

Design Practice Problems

Pavement 1 – Aggregate Surfaced Airfield

Design a single layer aggregate surfaced (unsurfaced) taxiway (Traffic Area B) for the conditions below. Assume a drainage layer is not required.

Traffic protection = 10,000 passes of a C-130H aircraft, gross weight = 61 235 kg (135,000 lb).

Layer	CBR	Thickness - mm (in)
Aggregate Surface	80	
Natural Subgrade	6	--

Pavement 2 – Aggregate Surfaced Road

Design a flat aggregate surfaced road for a 2-year life using conditions below. Assume a drainage layer is not required.

Traffic protection – 32,000 annual passes of M1A1, Abrams weight = 57 153 kg (126,000 lb).

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Layer	CBR	Thickness - mm (in)
Aggregate Surface	80	
Subbase	20	
Natural Subgrade	6	--

Pavement 3 – Mat Surfaced Airfield

Design an expedient runway using a Mat for a 146 510 kg (323,000 lb) C-141 at 3,500 passes for a Subgrade Category C (CBR = 6). Assume a drainage layer is not required. *Hint: when setting up your design, use a subbase CBR-20 to find the thickness and CBR of the material required to protect the subgrade. Assume Traffic Area A.*

Mat Type	Required Thickness Under Mat to Protect the Subgrade - mm (in)	Required CBR of Material Under the Mat
Light Duty		
Medium Duty		
Heavy Duty		

Pavement 4 – Flexible Surfaced Road

Design a flexible road for the military using the traffic and material information given below. The road will be located in the rolling hills near Atwood, Kansas. First determine if drainage is required (pavement thickness > 204 mm (8")), and if required, design for drainage. Assume frost is not a consideration.

Road Geometry: 7.3-meter (24-foot) transverse length, 1% transverse slope, 1% longitudinal slope

Traffic

Ground Vehicle	Weight – kg (lb)	Passes
Car, Passenger	1 361 (3,000)	850,000
M923, 5-ton cargo truck, 6 x 6	14 742 (32,500)	75,000
M977, HEMTT, 10-ton cargo truck	28 123 (62,000)	10,000
Truck, 2-axle, 6 tire	11 340 (25,000)	50,000
Truck, 4-axle	18 144 (40,000)	200,000

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Without Drainage

Layer	Description	Design CBR	Layer Thickness – mm (in)
Wearing Surface	Asphalt Cement (AC)	--	
Base Course	GW (unbound crushed stone)	80	
Natural Subgrade	CL (cohesive cut)	6	--

With Drainage

Layer	Description	Design CBR	Layer Thickness – mm (in)
Wearing Surface	Asphalt Cement (AC)	--	
Base Course	GW (unbound crushed stone)	80	
Drainage Layer	Uniform graded aggregate (permeability = 305 m/day (1000 ft/day), eff. porosity = 0.3)	50	
Separation Layer	GP (unbound aggregate)	50	
Natural Subgrade	CL (cohesive cut)	6	--

Compaction Requirements

Compaction (%)	Depth of Compaction Below the Pavement Surface – mm (in)
95	
90	

Pavement 5 – Flexible Surfaced Airfield

Design a flexible taxiway (Traffic Area B) for an Army Class IV airfield in Kuwait whose runway length is greater than 2 743 m (9000 feet). Use the material properties given below. Note: drainage is required for all Army airfield pavements.

Taxiway Geometry: 22.86-meter (75-foot) transverse length, 1.5% transverse slope, 1% longitudinal slope

Layer	Description	Design CBR	Layer Thickness – mm (in)
Wearing Surface	Asphalt Cement (AC)	--	
Base Course	GW	80	
Drainage Layer	GP - Medium to Coarse Sand Permeability = 610 m/day (2000 ft/day)	50	
Separation Layer	Geotextile	--	
Subbase Course	SP	20	
Natural Subgrade	SP	10	--

Pavement 6 – Flexible Surfaced Airfield

The FAA required the use of stabilized bases. Design an All Bituminous section for Traffic Area A using the traffic and material properties given below. Drainage and frost need not be considered.

Traffic

Air Vehicle	Weight kg (lb)	Passes
B-727	95 028 (209,500)	100,000
B-747	361 967 (798,000)	10,000
B-767	185 519 (409,000)	5,000
DC-10	264 444 (583,000)	10,000

Layer	Soil Classification	CBR	Layer Thickness - mm (in)
Wearing Surface	Asphalt Cement (AC)	--	
Stabilized Base Course	All Bituminous	100	
Natural Subgrade	SC	15	--

Pavement 7 – Flexible Surfaced Airfield

Design a new interior runway (type C traffic area) at McGrath, Alaska for Air Force Heavy traffic and the material conditions given below. Design for frost conditions. Also give the compaction requirements. Note: drainage is required when designing for frost.

Runway Geometry: 22.86-meter (75-foot) transverse length, 1% transverse slope, 1% longitudinal slope

Frost Penetration Depth	
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Layer	Soil Classification	Frost Code	Design CBR	Dry Unit Weight kg/m ³ (pcf)	% Moisture	Layer Thickness mm (in) Non-Frost	Layer Thickness mm (in) RSS	Layer Thickness mm (in) LSFP
Wearing Surface	Asphalt Cement (AC)	F0	--	2 323 (145)	0			
Base Course	Gravel-Sand (GW)	F0	80	2 163 (135)	5			
Drainage Layer	Bank run sands Permeability = 457 m/day (1500 ft/day)	F0	50	2 083 (130)	10			
Separation Layer	Gravel sand (GP)	F0	50	2 083 (130)	10			
Subbase Course	Silty Gravel (GM)	F0	25	2 003 (125)	15			
Natural Subgrade	Clay (CL), PI>12	F3	10	1 762 (110)	20	--	--	--
Total Thickness	--	--	--	--	--			

Which section should you use for design (circle the correct response)? **RSS** or **LSFP**

Compaction Requirements

Compaction (%)	Depth of Compaction Below the Pavement Surface mm (in)
85	
90	
95	

Pavement 8 – Rigid Surfaced Road/Street/Parking Lot

Design a vehicle maintenance area (PCC parking lot – flat terrain) for the traffic and material conditions given below. The site is located in Glasgow, Montana. Frost is a consideration and requires a drainage layer. The drainage layer will also serve as the base course. Vary the drainage layer thickness to determine the most economical section (when varying the thickness of the drainage layer be sure that you have sufficient thickness to fulfill the drainage requirements). *[Hint: calculate nonfrost conditions before calculating for frost conditions]*

PCC Flexural Strength = 4.48 MPa (650 psi), modulus 27 576 MPa (4,000,000 psi), Poisson's ratio 0.15, 0% steel

Parking Lot Geometry: 30.5-meter (100 ft) transverse length, 1.5% transverse slope, 1% longitudinal slope

Traffic

Ground Vehicle	Weight kg (lb)	Passes
Car, passenger	1 361 (3,000)	800,000
Crannell 79 – forklift	14 991 (33,050)	1,000
M1A1, Abrams main battle tank	57 153 (126,000)	100,000
M35A2, 2.5 ton cargo truck	8 528 (18,800)	1,000,000
R-11 Refueler	30 733 (67,755)	200,000

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Frost Penetration Depth	
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Layer	Description	Frost Code	Design K kPa/mm (pci)	% Moisture	Dry Unit Weight kg/m ³ (pcf)	Layer Thickness mm (in) Non-frost		Layer Thickness mm (in) RSS		Layer Thickness mm (in) LSFP	
						Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2
Wearing Surface	Portland Cement Concrete (PCC)	F0	--	0	2 323 (145)						
Drainage Layer	Uniform Graded Medium to Coarse Sand Permeability = 549 m/day (1800 ft/day)	F0	--	5	2 163 (135)						
Separation Layer	Geotextile	--	--	--	--	--	--	--	--	--	--
Natural Subgrade	Fine Grained	F3	41 (150)	20	1 923 (120)	--	--	--	--	--	--

Pavement 9 – Rigid Surfaced Road/Street/Parking Lot

An existing road provides access to the POV parking lot you designed in Pavement 8. The road has numerous distresses and requires an overlay. Using the existing pavement section below, determine the overlay requirements for a flat access road to the POV parking lot in Pavement 8 (use traffic from Pavement 8). Ignore frost and drainage requirements.

PCC Flexural Strength (existing and new PCC) = 4.48 MPa (650 psi), modulus 27 576 MPa (4,000,000 psi), Poisson's ratio 0.15, 0% steel

Existing Pavement Section

150 mm (6 in) PCC ($C_b = 0.50$, $C_r = 0.50$)*

102 mm (4 in) base

Subgrade $k = 41$ kPa/mm (150 pci)

Overlay Type	Thickness mm (in)
AC**	
PCC – partially bonded	
PCC - unbonded	

* A fully bonded overlay is not an option for pavements with $C < 1.0$.

** Being a conscientious engineer, you will notify the Commander that an asphalt overlay is not recommended because fuel trucks and tanks will be trafficking the pavement.

Pavements 10, 11, 12 and 13 – Rigid Surfaced Airfield

It is required that an Air Force airfield be designed as a modified-heavy pavement. Provide the Air Force MAJCOM designs using:

Pavement 10 – Plain PCC - Slab on grade

Pavement 11 – Reinforced PCC – Slab on grade

Pavement 12 – Unbound Base Course

Pavement 13 – Stabilized Base Course

On-site and laboratory investigations have yielded the following data required for design:

Subgrade

Material is classified as silty sand (SM)

Modulus of soil reaction, subgrade K= 41 kPa/mm (150 pci)

Frost does not enter subgrade material

Base Courses

A nearby source of crushed gravel meets the requirement for base course

Stabilized base, PCC stabilized – GW, Modulus = 5 515 MPa (800,000 psi) *(used for Pavement 13 only)*

Concrete

90-day concrete flexural strength, R= 4.83 MPa (700 psi)

Modulus = 27 576 MPa (4,000,000 psi)

Plain PCC - 0% Steel, Reinforced PCC – 0.20 Steel

Note: For Pavements 12 & 13, provide a pavement section that is the most economical in your area. For example, in the North/Midwest, it is more economical to provide sections where the PCC thickness is approximately equal to the base thickness. You will need to try different base thicknesses to come up with the most economical section.

Type Traffic Area	PCC Thickness mm (in)					
	Plain PCC Slab on Grade (Pavement 10)	Reinforced PCC (0.20% Steel) Slab on Grade (Pavement 11)	Plain PCC with Unbound Base Thickness (Pavement 12)		Plain PCC with Stabilized Base Thickness (Pavement 13)	
			Trial 1 Base Thick = __ mm (in)	Trial 2 Base Thick = __ mm (in)	Trial 1 Base Thick = __ mm (in)	Trial 2 Base Thick = __ mm (in)
A						
B						
C						
D						

Give the following joint information using your final design thicknesses from Pavement 12, using unbound base, Traffic Area A.

Joint Spacing meter (ft)	Dowel mm (in)		
	Spacing	Length	Diameter

Pavement 14 – Airfield Shoulder Pavement

Design flexible and rigid shoulder pavement for the previous airfield.

Flexible Shoulder

Layer	CBR	Thickness - mm (in)
Asphalt	--	
Base	80	
Natural Subgrade	6	--

Rigid Shoulder (Use the default numbers for all settings not listed)

Layer	Flexural Strength MPa (psi)	K kPa/mm (pci)	Modulus MPa (psi)	Poisson's Ratio	Thickness mm (in)
PCC	4.83 (700)	--	4,000,000	0.15	
Base	--	--	--	--	6.0
Natural Subgrade	--	40.65 (150)	--	--	--

Ground vehicles will also be utilizing the shoulder pavement. Check the shoulder pavements by performing a new design to ensure the shoulder pavements can support the vehicles listed below. *Hint: Set design type to "Roads". This will set the wander width as 847 mm (33.35").*

Traffic Pattern

Vehicle	Weight kg (lbs)	Passes
Car – Passenger	1,361 (3,000)	150
P-23 Crash Truck	35,326 (77,880)	200
R-11 Refueler	30,733 (67,755)	200

Flexible Shoulder for Ground Vehicles

Layer	CBR	Thickness - mm (in)
Asphalt	--	
Base	80	
Natural Subgrade	6	--

Rigid Shoulder for Ground Vehicles (Use the default numbers for all settings not listed)

Layer	Flexural Strength MPa (psi)	K kPa/mm (pci)	Modulus MPa (psi)	Poisson's Ratio	Thickness mm (in)
PCC	700	--	4,000,000	0.15	
Base	--	--	--	--	6.0
Natural Subgrade	--	40.65 (150)	--	--	--

What thickness should you use and why?

Pavement 15 – Airfield Overlay

An existing apron (Traffic Area B) subjected to Air Force modified-heavy traffic is to be overlaid. Provide thicknesses for the overlay based on the existing section below.

Existing Pavement Section

304 mm (12") PCC ($R_{\text{new and existing}} = 4.83 \text{ MPa (700 psi)}$, $C_b = 0.75$, $C_r = 0.75$)*

152 mm (6") base

Subgrade $k = 41 \text{ kPa/mm (150 pci)}$

Overlay Type	Thickness – mm (in)
AC**	
PCC – partially bonded	
PCC - unbonded	

* A fully bonded overlay is not an option for pavements with $C < 1.0$.

Pavement 16 – Rigid Surfaced Airfield (layered elastic method)

UFC 3-260-02, “Pavement Design for Airfields”, specifies that PCC be used for runway ends (305 meters (1,000 ft)), primary taxiways and aprons. Design a new PCC pavement section to replace the existing AC runway ends (Traffic Area A) using the current mission traffic given below. Use the LED method for design using the material data provided in the table below. Assume frost and drainage are not required but a minimum base course thickness of 152 mm (6”) is required.

Reminder – For layered elastic design be sure to set Analysis Type to “Individual” in the Traffic Module.

Traffic

Aircraft	Weight kg (lb)	365-day Period	20-year Traffic
B-727	95 500 (210,000)	8	160
C-9	50 000 (110,000)	104	2080
C-12	7500 (16,600)	2,200	44,000
C-17	263 000 (580,000)	30	600
C-130	70 000 (175,000)	48	960
C-141	156 000 (345,000)	1	20

LED Method – 1 Season

Layer	Modulus of Elasticity MPa (psi)	Poisson’s Ratio	Slip	Layer Thickness mm (in)
PCC Flexural Strength (R) - 4.83 MPa (700 psi)	27 576 (4,000,000)	0.15	1000	
Base Course	207 (30,000)	0.35	0	152 (6)
Subgrade	41 (6,000)	0.40	0	---

WRAFF sometimes experiences seasonal variations. Due to the potential weakening of the subgrade from thawing design the pavement for the seasonal variations given in the table below. *Hint: you can copy the previous design then “Edit Seasons”.* Be sure to change the modulus for each season.

LED Method – 4 Seasons

Material	Slip	Season 1 Jan - Feb		Season 2 Mar - Apr		Season 3 May - Sep		Season 4 Oct - Dec		Layer Thickness mm (in)
		E MPa (psi)	v	E MPa (psi)	v	E MPa (psi)	v	E MPa (psi)	v	
PCC R= 4.83 MPa (700 psi)	1000	27 576 (4,000,000)	0.15	27 576 (4,000,000)	0.15	27 576 (4,000,000)	0.15	27 576 (4,000,000)	0.15	
Base Course	0	276 (40,000)	0.35	172 (25,000)	0.35	207 (30,000)	0.35	241 (35,000)	0.35	152 (6)
Subgrade	0	69 (10,000)	0.40	31 (4,500)	0.40	42 (6,000)	0.40	55 (8,000)	0.40	--

Which vehicle caused the most damage to the surface?

Pavement 17 – Flexible Surfaced Road (layered elastic procedure)

A new access road to the airfield is required at WRAFF (flat terrain) for the traffic given in Pavement 4 (copy the pattern and set *Analysis Type* to “Individual”). Design a pavement using the Layered Elastic (LED) method and the layer structure outlined below. The base course layer will be used as the drainage layer.

Reminder – For layered elastic design, be sure to set *Analysis Type* to “Individual” in the *Traffic Module*.

LED Method – 1 Season

Layer	Modulus of Elasticity MPa (psi)	Poisson's Ratio	Slip	Layer Thickness – mm (in)
Asphalt	4 137 (600,000)	0.35	0	
Base Layer	207 (30,000)	0.35	0	
Subgrade	41 (6,000)	0.40	0	---

Due to the summertime heat, the modulus of the asphalt decreases. Design the pavement to account for the changes in modulus using the information below.

LED Method – 3 Seasons

Material	Slip	Season 1 Jan - Apr		Season 2 May - Sep		Season 3 Oct - Dec		Layer Thickness mm (in)
		E MPa (psi)	v	E MPa (psi)	v	E MPa (psi)	v	
Asphalt	0	6 894 (1,000,000)	0.35	1 379 (200,000)	0.35	5 171 (750,000)	0.35	
Base Layer	0	241 (35,000)	0.35	207 (30,000)	0.35	276 (40,000)	0.35	
Subgrade	0	55 (8,000)	0.40	41 (6,000)	0.40	69 (10,000)	0.40	--

In which season did the most damage occur to the subgrade?

Design Solutions

Pavement 1 – Aggregate Surfaced Airfield

Layer	CBR	Thickness - mm (in)
Aggregate Surface	80	320 (12.61)
Natural Subgrade	6	--

Pavement 2 – Aggregate Surfaced Road

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Layer	CBR	Thickness - mm (in)
Aggregate Surface	80	102 (4.00)
Subbase	20	325 (12.78)
Natural Subgrade	6	--

Pavement 3 – Mat Surfaced Airfield

Mat Type	Required Thickness Under Mat to Protect the Subgrade – mm (in)	Required CBR of Material Under the Mat
Light Duty	526 (20.72)	26.80
Medium Duty	346 (13.64)	20
Heavy Duty	102 (4.00)	20

Pavement 4 – Flexible Surfaced Road

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Without Drainage

Layer	Description	Design CBR	Layer Thickness - mm (in)
Wearing Surface	Asphalt Cement (AC)	--	64 (2.50)
Base Course	GW (unbound crushed stone)	80	313 (12.33)
Natural Subgrade	CL (cohesive cut)	6	--

With Drainage

Layer	Description	Design CBR	Layer Thickness – mm (in)
Wearing Surface	Asphalt Cement (AC)	--	64 (2.50)
Base Course	GW (unbound crushed stone)	80	103 (4.04)
Drainage Layer	Uniform graded aggregate	50	109 (4.29)
Separation Layer	GP (unbound aggregate)	50	102 (4.00)
Natural Subgrade	CL (cohesive cut)	6	--

Compaction Requirements

Compaction (%)	Depth of Compaction Below the Pavement Surface – mm (in)
95	305 (12)
90	457 (18)

Pavement 5 – Flexible Surfaced Airfield

Layer	Description	Design CBR	Layer Thickness – mm (in)
Wearing Surface	Asphalt Cement (AC)	--	127 (5.00)
Base Course	GW	80	152 (6.00)
Drainage Layer	GP - Medium to Coarse Sand	50	139 (5.44)
Separation Layer	Geotextile	--	--
Subbase Course	SP	20	279 (11.03)
Natural Subgrade	SP	10	--

Pavement 6 – Flexible Surfaced Airfield

Layer	Soil Classification	CBR	Layer Thickness – mm (in)
Wearing Surface	Asphalt Cement (AC)	--	85 (3.35)
Stabilized Base Course	All Bituminous	100	280 (11.01)
Natural Subgrade	SC	15	--

Pavement 7 – Flexible Surfaced Airfield

Depth of Frost Penetration	2 692 mm (106 in)
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Layer	Soil Classification	Frost Code	Design CBR	Dry Unit Weight Kg/m ³ (pcf)	% Moisture	Layer Thickness mm (in) Non-Frost	Layer Thickness mm (in) RSS	Layer Thickness mm (in) LSFP
Wearing Surface	Asphalt Cement (AC)	F0	--	2 323 (145)	0	127 (5.00)	127 (5.00)	127 (5.00)
Base Course	Gravel-Sand (GW)	F0	80	2 163 (135)	5	203 (8.00)	203 (8.00)	203 (8.00)
Drainage Layer	Bank run sands permeability = 457 m/day (1500 ft/day)	F0	50	2 082 (130)	10	102 (4.00)	102 (4.00)	102 (4.00)
Separation Layer	Gravel sand (GP)	F0	50	2 082 (130)	10	102 (4.00)	102 (4.00)	102 (4.00)
Subbase Course	Silty Gravel (GM)	F0	25	2 002 (125)	15	193 (7.59)	949 (37.37)	991 (39.00)
Natural Subgrade	Clay (CL), PI>12	F3	10	1 762 (110)	20	--	--	--
Total Thickness	--	--	--	--	--	727 (28.59)	1 483 (58.37)	1 525 (60.00)

Which section should you use for design (circle the correct response)? **RSS**

Compaction Requirements

Compaction (%)	Depth of Compaction Below the Pavement Surface – mm (in)
85	1 450 (57)
90	1 040 (41)
95	710 (28)

Pavement 8 – Rigid Surfaced Road/Street/Parking Lot

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Depth of Frost Penetration	1 727 mm (68 in)
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Layer	Description	Frost Code	Design K kPa/mm (pci)	% Moisture	Dry Unit Weight kg/m ³ (pcf)	Layer Thickness mm (in) Non-frost		Layer Thickness mm (in) RSS		Layer Thickness mm (in) LSFP	
						Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2
Wearing Surface	Portland Cement Concrete (PCC)	F0	--	0	2 323 (145)	162 (6.39)	160 (6.30)	220 (8.65)	203 (8.01)	162 (6.39)	160 (6.30)
Drainage Layer	Uniform Graded Aggregate	F0	--	5	2 163 (135)	102 (4.00)	152 (6.00)	102 (4.00)	152 (6.00)	1 041 (40.97)	1 042 (41.03)
Separation Layer	Geotextile	--	--	--	--	--	--	--	--	--	--
Natural Subgrade	Fine Grained	F3	41 (150)	20	1 923 (120)	--	--	--	--	--	--

Pavement 9 – Rigid Surfaced Road/Street/Parking Lot

Overlay Type	Thickness - mm (in)
AC	292 (11.5)
PCC – partially bonded	152 (6)
PCC - unbonded	165 (6.5)

Pavements 10, 11, 12 and 13 – Rigid Surfaced Airfield

Type Traffic Area	PCC Thickness – mm (in)					
	Plain PCC Slab on Grade (Pavement 10)	Reinforced PCC (0.2% Steel) Slab on Grade (Pavement 11)	Plain PCC with Unbound Base Thickness (Pavement 12)		Plain PCC with Stabilized Base Thickness (Pavement 13)	
			Trial 1 Thick=152 (6) mm (in)	Trial 2 Thick=380 (15) mm (in)	Trial 1 Thick=152 (6) mm (in)	Trial 2 Thick=380 (15) mm (in)
A	503 (19.80)	403 (15.87)	469 (18.48)	418 (16.45)	471 (18.53)	382 (15.03)
B	489 (19.29)	393 (15.46)	457 (17.98)	405 (15.96)	457 (18.01)	368 (14.46)
C	387 (15.29)	311 (12.25)	358 (14.11)	315 (12.39)	352 (13.87)	251 (9.85)
D	280 (11.04)	225 (8.85)	267 (10.52)	229 (9.02)	239 (9.41)	152 (6.0)

Joint Information based on Traffic Area A Section 417 mm (16.5”) plain PCC over 380 mm (15”) unbound base

Joint Spacing m (ft)	Dowel – mm (in)		
	Spacing	Length	Diameter
4.6 to 6.1 (15 to 20)	457 (18)	508 (20)	25 – 40 (1.0 -1.5)

Pavement 14 – Airfield Shoulder Pavement

Flexible Shoulder

Layer	CBR	Thickness - mm (in)
Asphalt	--	51 (2.0)
Base	80	263 (10.35)
Natural Subgrade	6	--

Rigid Shoulder

Layer	Flexural Strength MPa (psi)	K kPa/mm (pci)	Modulus MPa (psi)	Poisson's Ratio	Thickness – mm (in)
PCC	4.83 (700)	--	4,000,000	0.15	152 (6.0)
Base	--	--	--	--	152 (6.0)
Natural Subgrade	--	40.65 (150)	--	--	--

Pavement 14 – Airfield Shoulder Pavement (Cont'd)**Flexible Shoulder for Ground Vehicles**

Layer	CBR	Thickness - mm (in)
Asphalt	--	51 (2.0)
Base	80	221 (8.70)
Natural Subgrade	6	--

Rigid Shoulder for Ground Vehicles

Layer	Flexural Strength MPa (psi)	K kPa/mm (pci)	Modulus MPa (psi)	Poisson's Ratio	Thickness mm (in)
PCC	4.83 (700)	--	4,000,000	0.15	152 (6.0)
Base	--	--	--	--	152 (6.0)
Natural Subgrade	--	40.65 (150)	--	--	--

What thickness should you use and why? Use the thicker of the two designs. For Flexible shoulder use the design based on the single wheel load (51 mm (2") AC, 263 mm (10.35") base). For rigid shoulders either design is appropriate since they both default to the minimum of 152 mm (6") PCC.

Pavement 15 – Airfield Overlay

Overlay Type	Thickness – mm (in)
AC**	495 (19.5)
PCC – partially bonded	318 (12.5)
PCC - unbonded	381 (15.0)

Pavement 16 – Rigid Surfaced Airfield (layered elastic method)**LED Method – 1 Season**

Layer	Modulus of Elasticity MPa (psi)	Poisson's Ratio	Thickness - mm (in)
PCC	27 576 (4,000,000)	0.15	366 (14.39)
Base Course	207 (30,000)	0.35	152 (6)
Subgrade	42 (6,000)	0.40	---

Pavement 16 – Rigid Surfaced Airfield (layered elastic method) (Cont'd)

LED Method – 4 Seasons

Material	Season 1 Jan - Feb		Season 2 Mar - Apr		Season 3 May - Sep		Season 4 Oct - Dec		Thickness mm (in)
	E MPa (psi)	ν	E MPa (psi)	ν	E MPa (psi)	ν	E MPa (psi)	ν	
PCC	27 576 (4,000,000)	0.15	27 576 (4,000,000)	0.15	27 576 (4,000,000)	0.15	27 576 (4,000,000)	0.15	362 (14.27)
Base Course	276 (40,000)	0.35	276 (40,000)	0.35	276 (40,000)	0.35	276 (40,000)	0.35	152 (6)
Subgrade	69 (10,000)	0.40	31 (4,500)	0.40	41 (6,000)	0.40	55 (8,000)	0.40	--

Which vehicle caused the most damage to the surface? **C-17**

Pavement 17 – Flexible Surfaced Road (layered elastic procedure)

LED Method – 1 Season

Layer	Modulus of Elasticity MPa (psi)	Poisson's Ratio	Thickness mm (in)
Asphalt	4 137 (600,000)	0.35	89 (3.5)
Base Layer	517 (45,000)	0.35	241 (9.49)
Subgrade	42 (6,000)	0.40	---

LED Method – 3 Seasons

Material	Season 1 Jan - Apr		Season 2 May - Sep		Season 3 Oct - Dec		Thickness mm (in)
	E MPa (psi)	ν	E MPa (psi)	ν	E MPa (psi)	ν	
Asphalt	6 894 (1,000,000)	0.35	1 379 (200,000)	0.35	5 171 (750,000)	0.35	89 (3.5)
Base Layer	310 (45,000)	0.35	310 (45,000)	0.35	310 (45,000)	0.35	263 (10.37)
Subgrade	55 (8,000)	0.40	42 (6,000)	0.40	69 (10,000)	0.40	--

In which season did the most damage occur to the subgrade? **Season 2**